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6. AUTHOR(S) Eric I. Thorsos				
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9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Dr. Jeffrey Simmen (Code 3210A) Office of Naval Research 800 North Quincy Street Arlington, VA 22217-5660			10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
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Applied Physics Laboratory

College of Ocean and Fishery Sciences, University of Washington

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To: Dr. Jeffrey Simmen
ONR Code 321OA
Ballston Tower #1
800 N. Quincy Street
Arlington, VA 22217-5660

From: Eric I. Thorsos

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Under the subject grant titled "Numerical Study of Rough Surface Scattering" research was conducted on rough surface scattering using an exact numerical method based on solving an integral equation. Boundary conditions appropriate to both sea surface and sea bottom scattering were employed. Numerical studies were used to examine the accuracy of approximations used with scattering theory, and various scattering phenomena were examined directly with numerical simulations and modeling.

One important highlight from this work is that numerical simulations were used to show that roughness at the water/sediment interface could lead to significant acoustic penetration into sediment at incident grazing angles below the critical angle. This work played an important part in the development of the High Frequency Sediment Acoustics DRI which began in FY98. As part of the preparation for the DRI program, I chaired an ONR DRI Workshop in Monterosso, Italy, in July 1997.

An ONR High-Frequency Acoustics Workshop was held on 16-18 April 1996. I was moderator for the workshop, and subsequently completed a report on the workshop and the research issues raised. A separate contract was awarded for the report publication (ONR Grant No. N00014-96-1-0841), but that contract mainly covered the direct publication costs, including editorial support. The extensive effort required to develop the material and write the report was largely supported by the subject grant.

In addition to numerical work on sea surface and sea bottom scattering, a collaboration continued during the contract period with investigators in the CST program, an experimental program in low-frequency sea surface scattering. That work has also been supported in part by the subject grant and documented in several CST white papers.

Results of work supported by the subject grant are described in the following publications, which constitute the final report.

S.L. Broschat and E.I. Thorsos, "An investigation of the small slope approximation for scattering from rough surfaces. Part II. Numerical studies," *J. Acoust. Soc. Am.* **101**, 2615-2625 (1997).

E.I. Thorsos, D.R. Jackson, J.E. Moe, and K.L. Williams, "Modeling of subcritical penetration into sediments due to interface roughness," in *High Frequency Acoustics in Shallow Water Conference*, edited by N.G. Pace et al. (NATO SACLANT Undersea Research Centre, La Spezia, Italy, 1997) pp. 563-569.

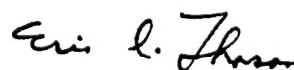
D.R. Jackson, E.I. Thorsos, and J.E. Moe, "Far field considerations in boundary scattering," in *Shallow Water Acoustics*, edited by R. Zhang and J. Zhou (China Ocean Press, Beijing, 1997).

E.I. Thorsos, "Report on the Office of Naval Research High-Frequency Acoustics Workshop, 16-18 April 1996," APL-UW TR 9702, June 1997.

F.S. Henyey, E.I. Thorsos, J.M. Grochocinski, D.M. Farmer, and S.H. Hill, "Measurement of Sea Surface Forward Scattering," SPAWAR CST/LLFA-WP-EVA-25, July 1996.

R.C. Gauss, J.M. Fialkowski, F.S. Henyey, P.M. Ogden, S.M. Reilly, M.T. Sundvik, and E.I. Thorsos, "Reassessing the Issue of Pulse-Length Dependence of Bottom Scattering Strengths in Critical Sea Test Data," SPAWAR CST/LLFA-R-EVA-9A, September 1996.

R.C. Gauss and E.I. Thorsos, "Critical Sea Test Surface Interaction Overview," SPAWAR CST/LLFA-WP-EVA-45A, December 1996. Distribution authorized to U.S. government agencies and their contractors; administrative/operational use (February 1993). Other requests for this document will be referred to COMSPAWARSYSCOM.



Eric I. Thorsos

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